

Atlas-Mercury One: A Complete Failure

Late in February 1960 the Air Force Ballistic Missile Division (BMD) and Space Technology Laboratories (STL) had been hosts for a meeting in Los Angeles of people from Convair/Astronautics, McDonnell, and the Task Group who were to determine the final details of the ultimate booster- capsule system for Project Mercury. Already STG had decided unilaterally, as was its prerogative, to make the next shot split the difference between the Big Joe development mission and a full qualification flight test of the Mercury-Atlas configuration on a simulated reentry from orbit. To the Task Group, this configuration and mission had long since been known as "MA-1," but Air Force and Convair engineers usually transposed the names and spoke of "Atlas-Mercury" No. 1. As in many other particulars, which things should be first still was debatable. Maxime A. Faget recorded his impression of the central technical debate at the Mercury-Atlas meeting on February 26:

STL/CVA representatives made an impassioned plea to use the escape tower on the MA-1 shot. Only with the escape tower on, can the Atlas people [273] determine the structural bending modes on the Atlas and, consequently, the adequacy of their control system to accommodate them. The writer explained that the tower was deleted from this flight only after a great deal of deliberation at the Space Task Group, that much water has gone over the dam since then, and to change now would be very difficult. Although I agreed to take back to the Space Task Group management their desires for further consideration, they were informed that there was virtually no chance that the change would be made.^{[25](#)}

As the MA-1 launch date approached, the Langley outfitters of the Big Joe capsule installed inside the shell of McDonnell's capsule No. 4 another instrumentation package, built by Lewis Research Center and STG electronics technicians. Shipped to the Cape in mid-May, loaded with 200 pounds of sensing instruments - including two cameras, two tape recorders, and a 16-channel telemetry system - the MA-1 payload was equipped to measure some 50 temperatures (mostly on the afterbody); pitch, yaw, and roll rates; positive and negative accelerations; cabin and external pressures; and noise and vibration extremes. Besides the missing 1,060- pound escape system, this payload also lacked the environmental control system, the astronaut couch and control panel, and the attitude-control and stabilization-control jets. An inert paste replaced the solid fuel in the retrorockets. For several months before the Atlas 50-D booster arrived at the Cape, Joseph M. Bobik, of the STG Launch Operations Branch, had work abundant as the inspector of the MA-1 capsule. Meanwhile Sigurd A. Sjoberg, John D. Hodge, Richard G. Arbic, John P. Mayer, and Robert E. McKann were hastily revising the mission directive, data acquisition plan, and general information on recovery requirements, landing area predictions, and a summary of calculated preflight trajectory data.^{[26](#)} Robert F. Thompson, Christopher C. Kraft, Jr., and Charles W. Mathews listed in order of importance the test objectives of the MA-1 flight:

1. Recover the capsule.
2. Determine the structural integrity of the Mercury capsule structure and afterbody shingles under the maximum heating conditions which could be encountered from an orbital launching.
3. Determine Mercury capsule afterbody heating rates during reentry (for this purpose 51 thermocouples were installed).
4. Determine the flight dynamic characteristics of the Mercury capsule during reentry.
5. Determine the adequacy of the Mercury capsule recovery systems.
6. Familiarize Project Mercury operating personnel with launch and recovery operations.^{[27](#)}

When capsule No. 4 actually arrived at Cape Canaveral on May 23, it was as complete as it was supposed to be except for flight instrumentation, parachutes, and pyrotechnic devices. Following a satisfactory test of the leakage rate of its [274] pressure shell, the capsule's miles of wiring were verified while the instrumentation system was subjected to final bench tests. Minor difficulties with instruments and in using a new weight-and-balance fixture added two weeks to the work period. For integrated systems tests to verify the sequencing and monitoring during the reentry, the capsule was moved into the newly constructed clean room in Hangar S.

When every minor discrepancy had been corrected and the calibration curves for various units had been established, the spacecraft was moved out to launch complex 14 for the first mechanical mating of a Mercury capsule with an Atlas booster. The alignment was good; no rework was required for the umbilicals or for the complex wiring in blockhouse consoles. But mechanical problems with Freon lines and with some electrical contacts in the mating ring caused a delay. Taken back to Hangar S for dismantling to rework certain instrumentation and telemetry packages, the capsule again was transported to the pad and mated to the launch vehicle in preparation for the flight acceptance composite test, known by its acronym, FACT. From July 13 to 18 engineers stood on the bascule of the gantry, working to conclude the FACT satisfactorily.

Meanwhile the Atlas crews were checking out their vehicle. Friendly rivalry between the propulsion and payload people produced many wagers over which system would cause the next postponement, and whether the capsule or the booster would be first to report "all systems go." On July 21, the flight readiness firing, which was a dress-rehearsal static-firing test, tested the three Atlas engines and measured the vibrations and acceleration strains suffered by the capsule. Atlas partisans won a bet at this point; atop this particular capsule the short metal legs of the "stub tower" created some unique antenna and telemetry difficulties with power amplifiers, commutators, and a high voltage standing wave ratio. The purpose of the "stub tower" was to support a thermal fairing over the antenna and parachute canister. Again the spacecraft was returned to the hangar. The tape recorders and cameras were removed, reloaded, and reinstalled. The telemetry was checked. The recovery section equipment was removed, then reassembled with live pyrotechnics. The capsule again was balanced, weighed, and aligned optically before its final union with the booster.^{[28](#)}

McDonnell's virgin spacecraft No. 4 moved to the seaside launch pad dressed in a polyethylene raincoat on July 24. This time it nestled nicely on top the Atlas, and the umbilical insertion and pull tests shortly certified readiness to begin the countdown. Wet weather made it difficult to keep the pyrotechnic connections dry, but otherwise preflight checkouts were completed on July 26, 1960. For the benefit of Administrator Glennan, George Low summarized the expectations for Mercury-Atlas 1:^{[29](#)}

The primary objective of this test is to determine the integrity of the Mercury capsule structure and afterbody shingles when subjected to the maximum heating conditions which could be encountered in any Mercury mission.

- Maximum velocity: 19,000 feet per second
- Maximum altitude: 98 nautical miles
- Range: 1,300 nautical miles
- Peak deceleration: 16.3 g
- Time of flight: 16 minutes

[275] Heavy rain pelted the Cape early on Friday morning, July 29, 1960, but the cloud ceiling rose high enough to be considered acceptable for a launching. During the final 35 minutes of countdown before

launch time (T), 48 minutes were accumulated by delays or "holds" because of bad weather; liquid oxygen tank-topping delays; and telemetry receiver difficulties. In the blockhouse Gilruth and Walter Burke watched Walter Williams direct operations and Aleck C. Bond, the project engineer, sweat away the minutes, while across the Cape at Central Control, other Air Force, Navy, and Convair officers and officials also watched and waited. Before their consoles in the blockhouse sat the Convair test conductors Kurt Johnston and William Williams; Scott H. Simpkinson, the payload test conductor; Harold G. Johnston, the ground instrumentation coordinator; Jacob Moser, the instrumentation engineer; B. Porter Brown, the launch coordinator; Richard Arbic, the range coordinator; and Donald C. Cheatham, the recovery coordinator. At 7:25 the weather looked cooperative in the impact area, where recovery aircraft and ships were reporting a visibility of five miles and a sea state of mild swells. So the gantry was ordered to back away, leaving MA-1 poised alone in the rain, ready for the final count. Intermittent holds for minor status checks left only 7 minutes of count at 9 o'clock.

Finally at 9:13 the man-made thunder clapped as the Rocketdyne engines spewed forth their reaction energy. The noise grew louder for several seconds as the Atlas pushed itself up on its fiery blast by inches, feet, and yards. Out of sight in seconds as it pierced the cloud cover, Atlas 50-D could still be heard roaring off in the distance. The initial phases of the launching appeared to be normal. Then everything went wrong:

About one minute after liftoff all contact with the Atlas was lost. This included telemetry and all beacons and transponders. About one second before telemetry was lost, the pressure difference between the lox and fuel tanks suddenly went to zero. It is not known whether this caused the failure or was an effect of the failure. There was no progression of unusual events leading up to this pressure loss. During the remaining second of telemetry, the Atlas flight path appeared to be steady.

By telephone and teletype data links, Low in Washington pieced together the bad news on MA-1 and continued to dictate an immediate preliminary report for the administrator and his staff:

As you know, the abort sensing system was flown open loop in this test. This system gave two signals to abort, apparently about the same time as the tank pressure differential was lost. These signals were monitoring missile electrical power and thrust; although the tank pressure differential was also monitored, no abort signal was received from this source. In the MA-1 mission, all of these signals were merely monitored, and were not connected to any of the capsule systems.

[276] The current speculation is that the Atlas either exploded, or suffered a catastrophic structural failure. Some observers reported that they heard an explosion, but this is not verified. The failure occurred at the time of maximum dynamic pressure, at an altitude of about 32,000 feet, and a velocity of about 1,400 feet per second.

The capsule separation systems were not to be armed until about three minutes after launch, and therefore the capsule remained attached to the Atlas or to pieces of the Atlas, until impact. Capsule telemetry continued to impact and indicated violent motions after the Atlas telemetry ceased. Temperatures and shingle vibrations flutter were recorded. Since all shingle thermocouples gave readings to splash, it is inferred that none of the shingles tore off. Impact occurred about seven miles off shore in an area where the water depth is roughly 40 feet. At the time of this writing, ships were still searching for debris.^{[30](#)}

It was a sad day for Mercury. It was especially frustrating for those nearest to the Atlas-Mercury phase, for they knew only that MA-1, either Atlas 50-D or capsule No. 4, or both, exploded on its way through max q. They did not know precisely what had happened because the weather had been so bad as to prevent visual and photographic coverage. In Washington, at Langley, at the Cape, and in southern California, postmortems were held for two weeks, until a conference on August 11 marshalled the parties most interested in the MA-1 malfunction, along with all the flight records, telemetry, and tape recorder data. Salvage operations had been able to recover only small portions of the capsule, the adapter-ring, and the booster. Presiding at this meeting was Major General Leighton I. Davis, the new commander of the Air Force Missile Test Center, who had relieved Major General Donald N. Yates in June as the Department of Defense single-point-of-contact for support of Project Mercury. On August 22, Warren J. North summarized the "quick-look" opinions of NASA and STL but not of Convair/Astronautics:

Both the NASA and STG localized the difficulty within the interface area between the capsule and the booster. A metallurgist from STL explained that it appeared the plumbing to the Atlas lox boiloff valve had failed due to fatigue. One would not ordinarily suspect a fatigue failure after such a short period of time, however, the NASA analysis showed that the lox valve plumbing could have failed if a 30 g oscillation existed at approximately 300 cycles per second. Culbertson (Convair) admitted that the lox valve was poorly supported and that 30 g was a feasible magnitude of acceleration. Vibration measurements show a two and one-half g vibration of the booster airframe, consequently a 12 g amplification factor would have been required at the lox valve.

Jim Chamberlin, STG, has been appointed chairman of a joint committee to resolve the MA-1 incident and provide a fix prior to MA-2. Initial reaction of this committee would cause the establishment of a hardware mockup at McDonnell which would include the pressurized lox tank dome, lox valve, adapter, and capsule. This mockup will be vibrated in order to isolate resonance or amplification factors.^{[31](#)}

[278] Two weeks later in San Diego, another committee of nine metallurgical engineers, a majority of whom were not from Convair, examined microscopically the hypothesis that MA-1 was destroyed by metal fatigue of the lox-vent valve elbow. "All conferees agreed finally that the factor at hand was not the primary one."^{[32](#)} The official flight test report issued two months later concluded with these remarks:

The Mercury Atlas No. 1 flight test was abruptly terminated approximately 58.5 seconds after launch by an in-flight failure of an undetermined nature. Solid cloud cover at the time of launch precluded the use of optical records in the investigation of this failure. The following conclusions are drawn regarding this flight test:

1. None of the primary capsule test objectives were met.
2. The structural integrity of the capsule was maintained throughout the flight until impact with the water. A substantial part of the adapter remained attached to the capsule to impact.
3. The capsule onboard instrumentation performed in a highly satisfactory manner throughout the flight.
4. The onboard instrumentation showed the presence of shingle vibration of a non-destructive nature.
5. All Department of Defense support for the operation was very good.^{[33](#)}

In mid-September one of the most important of the regular monthly meetings of the Mercury-Atlas coordination panel took place in the administration building at Patrick Air Force Base, Florida. Lieutenant Colonel Robert H. Brundin, Major Charles L. Gandy, and Captain I. B. Hanson were the BMD representatives, while Philip E. Culbertson and C. J. Holden represented Convair. Bernard A. Hohmann and Ernst R. Letsch were representing Aerospace Corporation, since STL was phasing out of Mercury. John Yardley, R. L. Foster, and J. T. Heard were present for McDonnell.

First and last on the agenda of this meeting were questions concerning better ways of inspecting and solving problems at the interface between the capsule and the booster. Charles Mathews, the chairman, began the meeting by insisting that in spite of the MA-1 failure, the overall Mercury-Atlas schedule could still be maintained. Hohmann suggested that a new seven-man joint capsule-booster interface inspection committee be established. This was done, and members representing all contributing organizations were named. Regarding the unsettled question of MA-1, Mathews briefly described several fruitless fact-finding activities and the need for additional instrumentation to determine the cause of failures like MA-1. No new hypothesis had yet emerged from the several test programs, so the 23 members of this coordination panel reexamined each other's previous answers to the enigma of MA-1. The 11 members from STG vetoed a proposal by the Air Force Ballistic Missile Division to establish still another "Mercury-Atlas interface panel."³⁴

Although the MA-1 investigation was unsatisfying, the launch operations committee reported that MA-2 was so nearly ready for a November launching that [279] there was little time for looking backward and no time for regret. Then on September 26, 1960, a lunar probe attempt by NASA, using Atlas Able 5-A, also failed severely. This forced a wholesale review of the Atlas as a launch vehicle. Everybody responsible for MA-1 was trying to determine the cause of that failure, but each only discovered that there were too many other bodies, both organic and organizational, partly responsible.

Late in October, before the national elections and before another Mercury flight test had come to pass, Gilruth and Williams held another periodic press conference for the benefit of curious reporters. Inevitably the question was asked, "Are you satisfied that you have pinpointed the reason for the MA-1 failure?" "No," Gilruth answered. "We successfully salvaged the capsule and can account for all parts." His interrogator continued, "Do you believe that parts in the Atlas' upper stage caused the failure?" Gilruth replied, "We have explored this. We have answered all of the questions we have asked ourselves - but have we asked the right questions? We can't be sure. That is one of the reasons we are repeating the test. And on MA-2 the interface area will be heavily instrumented."³⁵

When MA-2 finally became ready for launch, toward the end of February 1961, the managers of Mercury knew that a repetition of a total failure like MA-1 could easily cause abandonment of the project. The entire promise of the American manned space flight program seemed to hang in the balance. The technical aftermath of MA-1, during the politically sensitive period of the Presidential election and the lame-duck session of Congress, made interrelated technical and political considerations more acute than ever. To distinguish between the two soon became virtually impossible.

²⁵ Memo, Faget to Flight Systems Div., "Mercury-Atlas Meeting on Feb. 26, 1960 at Space Technology Laboratories," March 4, 1960, 3.

²⁶ NASA News Release 60-233, "MA-1 Capsule Instrumentation," undated; memo, Charles J. Donlan to Langley Research Center, attention Clyde Thiele, "Inspection of MA-1 Capsule," March 18, 1960;

memo, R. E. McKann to Chief, Flight Systems Div., "Trip to Mercury Project Office at Patrick Air Force Base," April 14, 1960. The basic preflight documentation for MA-1 is found in the following NASA Project Mercury working papers: "MA-1 Mission Directive," No. 132, April 11, 1960; "General Information for MA-1 Recovery Force," No. 142, July 8, 1960; "Landing Area Prediction MA-1," No. 143, July 13, 1960; "Summary of Calculated Preflight Trajectory Data for MA-1," No. 144, July 25, 1960. See also "Data Acquisition Plan, MA-1," undated; and "Project Mercury Description of Plans for MA-1," prelaunch report, June 24, 1960.

²⁷ Letter, Walter Williams to Cdr., DesFlotFour, March 15, 1960, with enclosure, "Test Objectives and Recovery Requirements for the Project Mercury Atlas Test One."

²⁸ Detailed descriptions of preflight operations for all Mercury launches are summarized in Ms., George F. Killmer, Jr., et al., "Mercury Technical History - Preflight Operations," MSC Florida Operations, Dec. 30, 1963. For MA-1, see pp. 68-71. For an overview of the coordination and cooperation mechanics among the Mercury-Atlas team, see letters, Silverstein to Courtland D. Perkins, Asst. Secy. of the Air Force (R and D), Aug. 26, 1960, and Gilruth to Silverstein, "Project Mercury Coordination between NASA-MAC and BMD-STL-Convair," Aug. 26, 1960, with enclosures.

²⁹ Memo, Low to Administrator, "Mercury-Atlas Test No. 1," July 26, 1960. For the more general "man-rating" procedures for the Atlas Booster about this time, see STL report TR-60-0000-69079, "Atlas Booster Flight Safety Review General Operating Procedures and Organization," June 6, 1960.

³⁰ Memo, Low to Administrator, "Mercury-Atlas 1, Post-Launch Information," July 29, 1960; see also Ms., "MA-1 Operation, 7/29/60," launch diary, anon. This same day George Low delivered a paper before the first NASA-Industry Conference that officially and publicly named for the first time "Project Apollo" as a manned lunar circumnavigation program for the future: see *NASA-Industry Program Plans Conference*, Washington, D.C., July 28-29, 1960, 80.

³¹ Memo, North to Administrator, "Analysis of MA-1 Malfunction," Aug. 22, 1960. See also Sally Anderson, ed., *Final Report Mercury/Atlas Launch Vehicle Program*, Aerospace Corp. report No. TDR-269 (4101)-3, El Segundo, Calif., Nov. 1963, VIII-14.

³² Joseph A. Kies, Naval Research Laboratory, Washington, "Atlas-Mercury Failure: Examination of Failed Parts," report, Aug. 30, 1960, 3; Andre J. Meyer, Jr., "Trip Report," Aug. 30, 1960.

³³ "Flight Test Report for Mercury-Atlas Mission No. 1 (capsule No. 4)," NASA Project Mercury working paper No. 159, Nov. 4, 1960, 12-1. Some idea of the complexity of data reduction procedures for Mercury in general and of the impact of MA-1 on data coordination procedures in particular may be gleaned from the draft Ms. by Richard G. Arbic and Robert C. Shirley, "Data Coordination," for Mercury Technical History, Part III, M., July 10, 1963.

³⁴ Minutes, "Mercury-Atlas Coordination Panel, Sept. 14, 1960," Sigurd A. Sjoberg, secretary, with enclosures, Sept. 29, 1960.

³⁵ Transcript, "Press Group Interview with Gilruth, Williams," Oct. 26, 1960, 2. Leading questions were asked by Douglas Dederer of the *Cocoa (Fla.) Tribune*. Gilruth also was reported to have said that he would not be surprised "to wake up any morning" to find the Soviets had accomplished manned orbital flight. Alvin B. Webb, Jr., *Washington Post*, Oct. 30, 1960. Webb also editorialized to say, "Mercury -

named for a winged-footed Roman God - appears to have both feet in a molasses vat." House Committee on Science and Astronautics, 87 Cong., 1 sess. (1961), *A Chronology of Missile and Astronautic Events*, 123, 124, 132; Sheldon, "The Challenge of International Competition," passim.

